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Trends in Mangrove meiobenthic studies in India: an overview

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Abstract In spite, of being the most threatened coastal habitats in the world, mangrove ecosystems offer a host of goods and services to the coastal communities. With over 4,975 sq.km of the mangrove area, India has the largest mangrove in Asia that constitutes about 45% of the total mangrove cover in South Asia. Mangroves are ecologically significant for their role in shoreline protection but it also acts as important reservoirs of biodiversity comprising both terrestrial and aquatic species. In the present communication, we reviewed the published literature on meiofauna found associated with mangroves. These microscopic organisms occur in very high densities in mangrove sediment and thus constitute a major component of the diet of commercially important fish and prawn larvae. In addition to the importance of meiofauna in the benthic food chain, larval feeding, meiofauna is also used very effectively in coastal environmental monitoring. While a significant number of scientific reports are published involving studies on meiofauna of Indian mangroves, the majority of these studies have focused only on the phylum of taxon or group level identification. Moreover, only a few of the studies have highlighted the role of food availability and abundance of meiofauna within the mangrove mudflat. Consequently, we recommend that future studies should explore the role of meiofaunal species, especially the dominant taxa, in the mangrove ecosystem functioning.

Trendy w badaniach meiobentosu namorzynowego w Indiach: przegląd

Słowa kluczowe meiofauna, namorzyny, Indie, trendy badawcze

Streszczenie Pomimo tego, że są najbardziej zagrożonymi siedliskami przybrzeżnymi na świecie, ekosystemy namorzynowe oferują społecznościom przybrzeżnym wiele dóbr i usług. Z ponad 4975 km^2 powierzchni namorzynów, Indie mają około 45% całkowitej pokrywy namorzynowej w Azji Południowej. Namorzyny mają znaczenie ekologiczne ze względu na swoją rolę w ochronie linii brzegowej, ale pełnią również funkcję ważnych rezerwuarów różnorodności biologicznej obejmującej zarówno gatunki lądowe, jak i wodne. W niniejszym komunikacie dokonaliśmy przeglądu opublikowanej literatury dotyczącej meiofauny związanej z namorzynami. Te mikroskopijne organizmy występują w bardzo dużym zagęszczeniu w osadach namorzynowych, a zatem stanowią główny składnik diety larw ryb i krewetek ważnych z handlowego punktu widzenia. Oprócz znaczenia meiofauny w bentosowym łańcuchu pokarmowym, żerowania larw, meiofauna jest również bardzo skutecznie wykorzystywana w monitoringu środowiska przybrzeżnego. Chociaż opublikowano znaczną liczbę doniesień naukowych dotyczących badań nad meiofauną indyjskich namorzynów, większość tych badań skupiała się jedynie na identyfikacji taksonów. Co więcej, tylko kilka badań podkreśliło rolę dostępności pożywienia i obfitości meiofauny w murawach namorzynowych. W związku z tym zalecamy, aby w przyszłych badaniach zbadać rolę gatunków meiofaunalnych, zwłaszcza taksonów dominujących, w funkcjonowaniu ekosystemu namorzynowego.

Introduction

'Ecologically, the mangrove environment, bordering tropical and subtropical estuaries and open seafront, represent a transitional area between the marine and terrestrial biotopes and thus forms an integral part of the intertidal or littoral zone' (Parulekar, 1994). Mangroves swamps or forests are typical of sheltered shores in the tropics and subtropics.

India had a mangrove cover of about 6,749 km^2, the fourth largest mangrove area in the world (Naskar, Mandal, 1999). About 8% of the Indian coastline is reported to be occupied by mangroves (Untawale, Wafar, Jagtap, 1982). It has been estimated that about 82% of the total mangrove forest in India, is along the east coast (including Andaman-Nicobar Islands), while the west coast of India has only 18% mangrove cover (Untawale, 1984). However, a recent assessment shows that India has a total mangrove cover of only 4,628 km^2 (FSI 2013), or 0.14% of the country's land area, 3% of the global mangrove area, and 8% of Asia's mangroves. Mangroves are declining rapidly as they are getting degraded for agriculture, aquaculture, tourism, urban development and over-exploitation. Consequently, India lost ~40% of its mangrove area during the last century (Sahu, Suresh, Murthy, Ravindranath, 2015).

India's mangroves can be broadly categorized into three types according to Thom's classification of estuary habitats: a) Deltaic – found along the east coast within the deltas of the Ganges, Brahmaputra, Mahanadi, Krishna, Godavari and Cauvery rivers etc; b) Backwater-estuarine – found on the west coast in the estuaries of the Indus, Narmada and Tapti Rivers. They are also growing in the backwaters, creeks and neritic inlets of these areas and c) Insular types – is found in the Andaman and Nicobar Islands (Mandal, Naskar, 2008; Sahu et al., 2015).

Mangroves are ecologically significant for their role in shoreline protection and also act as important reservoirs of a large number of species. Mangrove leaves that fall onto the sediment decompose and a succession of species found associated with their decomposition (Schrijvers, Okondo, Steyaert, Vincx, 1995; Gee, Somerfield, 1997; Somerfield, Gee, Aryuthaka, 1998; Zhou 2001). Meiofauna play an important role in litter degradation of mangrove sediment (Nagelkerken et al., 2008). Meiofaunal organisms also constitute the major component of the diet of larval forms of fish, crustaceans and other macro-organisms (Coull, Greenwood, Fielder, Coull, 1995; Dittel, Epifanio, Cifuentes, Kirchman, 1997). The breathing root, pneumatophores in mangroves are colonised by macro-epibenthos (eg. algae, sponges or barnacles), also promote the presence of meiofauna (Gwyther, Fairweather, 2005; Pinto et al., 2013).

Studies of meiofauna in the mangrove have been conducted in India (e.g., Krishnamurthy, Sultan Ali, Jeyaseelan, 1984; Ansari, Sreepada, Matondka, Parulekar, 1993; Kondalarao, 1983; Sarma, Wilsanand, 1994; Thilagavathi, Das, Saravanakumar, Raja, 2011), Australia (Hodda, Nicholas, 1985; Alongi, 1987a, b, c, 1988, 1990; Alongi, Christoffersen, 1992; Abdullah, Lee, 2017), South Africa, Kenya and associated area (Dye, 1983a, b; Ólafsson, 1995; Ólafsson, Carlström, Ndaro, 2000; Mutua, 2013), Malaysia (Sasekumar, 1994; Somerfield, 1998; Gee, Somerfield, 1997), America (Hopper, Fell, Cefalu, 1973; Fell, Cefalu, Masters, Tallman, 1975), Caribbean islands (Armenteros et al., 2006) etc.

Considering the ongoing global loss of mangrove habitats, it is necessary to raise awareness of the biodiversity of mangrove-associated fauna that might soon be lost, and hence there is an urgent need to work on biodiversity conservation. In the present study, we have undertaken a review of trends in mangrove meiobenthic studies in India and attempted to compare the Indian research with global status.

Results

A brief idea about the Research publications

In the early 1970's Ganapati and Sarma studied the meiofauna and pollution in Visakhapatnam (Andhra Pradesh) harbour. In this study, one of the stations was on an open mangrove swamp and comparatively free of pollution. Samples from this area were used as a baseline for comparison with those from other stations subjected to pollution from harbor-related activities. It was also found that maximum densities of meiofauna, both qualitatively and quantitatively were in the mangrove swamp extension (Ganapati, Sarma, 1973).

Sultan Ali, Krishnamurthy and Prince Jeyaseelsn (1983) studied the composition of nematodes in connection with the energy flow of the mangrove ecosystem in Pichavaram, Tamil Nadu.

Krishnamurthy et al. (1984) investigated meiofauna from intertidal sediments of Pichavaram mangroves, Tamil Nadu, Southeast coast of India and recorded total densities in the range of 35–280 individuals per 10 cm^2 with 27 genera and 4 species of nematodes.

Kondalarao (1983, 1984) studied the meiobenthic harpacticoid copepods in Goutami Godavari estuarine system and reported the mean highest density of harpacticoid at a station located in a mangrove biotope. Murty and Kondalarao (1987) also studied meiofauna from Goutami Godavari estuarine system with a station in mangrove biotope.

Nematodes were the dominant taxon followed by copepods in South Andaman mangrove sediments; the bulk of fauna occur in superficial layers of the sediment (Rao,1986).

Sinha, Choudhury and Baqri (1985) described a new species of nematode *Indoditylenchus sundarbanensis* based on females from detritus-rich mangrove litter soil around roots of *Avecennia officinalis* at the Prentice island, Sundarban, West Bengal. Subsequently, Sinha, Baqri and Choudhury (1989) described the male *I. sundarbanensis* from the same locality. Das and Roy (1989) and Mandal and Nandi (1989) reported some free-living nematodes from the mangrove area of Andaman and Nicobar Islands and Sundarban respectively. Sinha et al. (1987) recorded a new species of nematode *Anoplostonla macrospiculum* from the mangrove environment of deltaic Sundarbans, West Bengal, India. While Sinha and Choudhary (1988) also reported seventeen stylet bearing nematodes from the Sunderbans mangrove. Sinha et al. (1989) also described a new nematode species *Nothocriconema bengalensis* based on females from mangrove litter soil around roots of *Excoecaria agalocha*, *Acanthus ilicifolins*, *Broguiera gymnorhyza* in the mid littoral zone of Harinbari mangrove swamp, Sagar island, Sundarban, West Bengal. Das and Dev Roy (1989) have provided a list of meiofauna from the mangrove sediments of south Andaman.

Meiobenthic fauna of Saphala salt marshes (extended estuarine wetlands or mudflats lined by fringing mangroves) of the west coast of India was reported by Ingole, Ansari and Parulekar

(1987). The salt marsh falls under the backwater of river Vaiterna and two bifurcating creeks, Sarwar and Mande north of Mumbai. Both the creeks have dense mangrove vegetations comprised of *Avecennia officinalis*, *A. marina* and *Ceriops tagal*. The meiofauna comprises 10 taxonomic groups dominated by nematodes, harpacticoids, turbellarians, crustacean nauplii, and polychaetes. While describing the harpacticoid community of the Saphala mangrove –salt marsh, in northern Maharashtra Ingole, Ansari and Parulekar (1990) reported 21 copepod species. Most dominant among the copepods were *Stenhelis longifurca; Helectinosoma curticorne* and *Ctenocamptus confluence* which accounted for >60% of the harpracticoid population density.

Ansari et al. (1993) worked at Chicalim, on the south bank of Zuari estuary Goa, sediment from mangrove mudflat. The sediment was loose mud comprising of silt and detritus derived from mangrove foliage. Mangrove community was dominated by *Avicennia officinalis* and *Snneratia alba*. They also described the meiofaunal stratification in relation to available microbial food. The density of meiofauna was greater near the surface and decreased with increasing depth into the sediment. The meiofaunal abundance was related to the availability of food such as chlorophyll-a concentration, diatom number and bacteria count. Meiofauna was dominated by nematode followed by Turbellaria, harpacticoids, oligochaetes and gastrotrichs. Among biochemical components, total organic matter and ATP showed a positive significant correlation with the meiofaunal density.

Sarma and Wilsanand (1994) reported the littoral meiofauna of Bitrakanika mangroves sediments of river Mahanadi system, in the Orissa state, east coast of India. They concluded that meiofauna was comprised of 11 major taxa, of which nematodes were the dominant group.

Goldin, Mishra, Ullal, Athalye and Gokhale (1996) studied meiobenthos in clayey silty sediment of mangrove (*Avicennia laba*) mudflat from the shallow region of Thane creek, south of Mumbai harbour Maharashtra, the central west coast of India. Meiofauna was dominated by nematodes. The silt constituent often showed a significant positive correlation with meiobenthic and nematode abundance and a negative correlation with tube building polychaetes. They commented 'A significant observation was the absence of copepods in the meiobenthos indicating the high intensity of pollution". They also commented on another significant point that the higher presence of macrobenthos in some stations reduced the meiobenthic contribution by approximately 38% suggesting that the meiobenthic abundance is mainly governed by interaction with macrobenthos rather than any other parameters.

Kumar and Hussain (1997) reported 10 ostracode species from the sediments of Pitachavaram mangrove while Arul, Sridhar, Hussain, Darwin Felix and Periakali (2003) reported 29 species from the same area.

Sunil Kumar (2000) made a review on soil-dwelling organisms in Indian mangroves and also reported work on meiofauna from Indian mangroves along with co-authors. Sunil Kumar (2001) also made a checklist of polychaetes annelids from the Indian mangrove environment.

Chinnadurai and Fernando (2003) studied the meiofaunal density in Pitchavaram mangrove, along with environmental variables like temperature, salinity, dissolved oxygen, organic carbon and sediment. *Rhizophora apiculata* and *Avicennia marina* mangroves grow in that area. The mangrove regions harbour a very high density of meiofauna though not very diverse. Chinnadurai and Fernando (2006a) reported new records of nematodes from Pitachavaram mangrove sediments. Six species viz. *Ptycholaimellus ponticus, Paracomesoma dubium, Desmodora* (*Desmodorella tenuispiculum, Camacolaimus barbatus, Haliplectus dorsalis* and *Thalassomonhystera parva*) and one genus (*Pseudolella* sp) were recorded for the first time from the intertidal sediments. Chinnadurai and Fernando (2006b) made a survey to examine spatial variations of meiofaunal population density and the assemblage of free-living marine nematodes from areas with different mangrove cover from Cochin, Kerala, Southwest coast of India. Seven major taxa were recorded. Nematodes were the most dominant taxon, contributing 51.2–97.3% of the total fauna. A maximum meiofaunal density of 508 ind. 10 cm^2 was recorded in an area with *Avicennia marina* cover. A total of 16 nematode genera belonging to 23 species were recorded with *Dorylaimopsis* being the abundant genus in areas with *A. marina* and *Sonneratia caseolaris* mangrove cover and *Daptonema* in areas with *Rhizophora apiculata* cover. Eleven genera were observed in the area with *A. marina* cover compared to *R. apiculata* and *S. caseolaris* cover, which harboured nine genera. Only one species (*Daptonema oxycerca*) was common to all five stations regardless of plant cover. Epistrate-feeders constituted the bulk of the nematodes in areas with *A. marina* and *S. caseolaris* cover, whilst deposit-feeders/ ciliate feeders were dominant in areas with *R. apiculata* cover. The maximum concentration of meiofauna especially nematodes, copepods, and kinorhynchs were found during summer in Pitchavaran mangrove area (Chinnadurai, Fernando, 2003). Five species of free-living marine nematodes are recorded from intertidal sediments of an artificial mangrove environment at Parangipettai, southeast coast of India for the first time (Chinnadurai, Fernando, 2006c).

Chinnadurai and Fernando (2007a) conducted an experiment at the Vellar estuary to investigate the impact of mangrove leaves on meiofaunal density. It was observed that immediately after the next day of the experiment, meiofaunal abundance was observed more in areas with *Avicennia marina* leaves than the control, while in areas with *Rhizophora apiculata* leaves, the density was always less than the control. The differences in the texture and quality of the mangrove plant determine the composition and abundance of the meiofaunal populations.

Chinnadurai and Fernando (2007b) described the spatial variations of meiofauna population density and the assemblage of free-living marine nematodes in areas with *Avicennia marina* and *Rhizophora apiculata* from Pichavaram and Parangipettai (southeast coast of India). Seven meiofauna taxa were recorded, with a maximum density of meiofauna in an area with *A. marina* cover. Nematodes accounted for up to 93.1% of the total densities followed by Foraminifera and Polychaeta. A total of 44 species of nematodes belonging to 36 genera and 20 families were recorded. Of these, 37 species belonging to 30 genera and 17 families were recorded from Pichavaram mangrove and 14 species belonging to 10 families from a nearby artificial mangrove environment.

Thilagavathi et al. (2011) reported meiofauna in Muthupettai mangrove forest, east coast of India located in Sethukuda and compared with the adjacent open sea. *Avicennia marina* is the predominant mangrove species in the mangrove forest, which determines the particles size present in the sediment, mainly inhabiting burrowers such as nematodes and higher density of meiofauna.

Rajeshwararao, Geetha and Shanmhugavel (2012) carried out detailed investigations on benthic foraminifera taxonomy and ecology of two mangrove areas (new artificially planted mangroves at Pazhaiyakayal and the old, already flourishing mangroves near the salt pans, south of Tuticorin). They reported 19 benthic foraminiferal species.

Savurirajan, Jayabarathi, Padmavati and Ganesh (2012) studies meiofauna in mangrove regions of Burmanallah, Carbyn's Cove, Panighat and Sippighat of Andaman & Nicobar Islands. They reported 30 genera under 22 families of meiobenthic groups were recorded; among the different groups, the nematodes were recorded 9 genera representing 7 families and the polychaetes, 6 genera under 5 families.

Sundaravarman, Kathiresan, Saravanakumar and Balasubramanian (2012) studied macro and meiofauna of Muthupet mangrove forest in Tamilnadu and reported foraminiferans as the dominant in density followed by nematodes, turbellarians, ostracodes and harpaticoid copepods.

Sahoo, Suchiang, Ansari (2013) studied the meiofauna in mangroves from 'Salim Ali Bird Sanctuary' (SABS), Chorao Island, Goa, central west coast of India. The study region is a mixed mangrove area having patches *of Sonneratia alba, Rhizophora mucronata, Avicennia officinalis,* and *Bruguiera cylindrica*. *Lumnitzera racemosa, Aegiceras corniculatum, Excoecaria agallocha, Acanthus illicifolius, Xylocarpus* spp. are sparsely distributed. They recorded 12 meiofaunal taxa from the sediments of the four vegetations. Nematodes dominate in the sediment of all vegetation and the density ranged from 71.2–76.3%. *Sonneratia* harboured 11 taxa followed by *Rhizophora* (eight taxa), *Bruguiera* (eight taxa) and the minimum *Avicennia* (seven taxa). They further reported that harpacticoid copepods were the second dominant group in *Avicennia* and *Rhizophora* constituting 17.9% and 17.4% respectively; whereas in *Sonneratia* copepods were replaced by foraminifera (10.5%) and in *Bruguiera* by oligochaetes (9.3%) although harpacticoids were present in significant numbers (9.1%).

Ansari, Manokaran, Raja, Lyla and Khan (2014) analysed free-living marine nematode diversity between *Avicennia marina* and *Rhizophora mucronata* mangrove covers of the Vellar Estuary (southeast coast of India). A total of 4,976 specimens of free-living marine nematodes were collected belonging to 56 species. Comparatively, a higher species richness was obtained for *A. marina* (52 species) than for *R. mucronata* (44 species), whereas 40 species commonly existed in both mangrove covers. A higher density of nematodes was found in sediments of sandy nature, whereas there was lower total organic carbon compared to silt/clay composition; epigrowth feeders were dominant over the other feeding groups based on organic enrichment in surface sediments.

Vidya and Patil (2014) studied the foraminifera assemblages in mangrove sediment from Chithrapu, Karnataka and Kumbla, Kerala. They reported 59 species belonging to 32 genera.

Bhaduri et al. (2015) provided a list of free-living nematode species recorded from the selective sandy beach sediments, including some collections from the estuarine – mangrove regions. Ten families, 16 genera and 24 species were encountered from the muddy mangrove sediments. Intrestingly four families viz. Anoplostomaeidae, Comesomatidae, Anoplostomoeidae and Linhomoeidae were exclusively found in muddy mangrove habitat.

Annapurna, Rao and Vijaya Bhanu (2015) reported meiofauna from Kakinada Bay, Gaderu and Coringa estuarine complex. The is bound on the south by dense mangrove vegetation and extensive mudflats intercepted by a network of tidal creeks, estuarine gullies and swamps emanating from one of India's largest river systems namely, the river Godavari. The meiobenthic abundance was dominated by Nematoda (37%), Copepoda (15.0%), Foraminifera (13.1%), Polychaeta (9.9%), Ostracoda (6.2%), Archiannelida (2.0%), Kinorhyncha (2.4%) and others (14.3%). Nematodes were the dominant group and contributed on an average 45.61% (monsoon), 36.17% (post-monsoon) and 33.91% (pre-monsoon) of the total meiobenthic fauna. Copepods were the second largest group, constituted on an average 6.34% (monsoon), 13.19% (postmonsoon) and 20.71% (pre-monsoon) of the total meiobenthic fauna.

Kurapati, Dogiparti, Daddu (2016) studied meiofauna in Bhavanapadu creek, Srikakulam, Andhra Pradesh (east coast of India). The dwarf mangroves occupied along the creek act as a good habitat for faunal diversity. The main meiofauna groups were copepods, nematodes and foraminiferans. Nematodes were mostly observed in clay regions of mangrove areas.

Parsath, Balasubramaniam, Marimuthu and Jayaraj (2017) reported two marine nematodes species *Sphaerolaimus balticus* and *S. islandicus* from Sipphighat mangrove region of South Andaman. Parsath, Balasubramaniam and Jayraj (2018) also reported spatial and seasonal variations in the population density and the assemblage of free-living marine nematodes in the mangrove sediments of the Andaman Islands. The decrease in the nematode community in mangrove habitat of Andaman Islands during monsoon may be due to fluctuation in temperature, low salinity and low organic carbon and presumed that environmental factors like temperature, salinity, pH, and and sand could also influence the community structure (Parsath et al., 2018).

Ansari and Bhadury (2017) provided a checklist of free-living marine nematodes from the mangrove ecosystem of Sundarbans (Bay of Bengal). The species list contains 179 species in 84 genera and 29 families.

Halacarid mites associated with mangroves were studied by Chatterjee, Marshall, Guru, Ingole and Pesic (2012) and reported a new species *Acarothrix grandocularis* from algal turf growing on *Avicennia* mangrove pneumatophores at Chorao Island, North Goa. Details of this mite species with scanning electron microscopic study was given by Chatterjee (2019) based on specimens collected from the Chorao Island (North Goa), Virnoda Pernem (North Goa), Chicalim Vasco (South Goa) and Chinchinim (South Goa) among algal turf growing on pneumatophores of mangroves *Avicennia* sp and *Rhizophora* sp or in mudflat associated with mangroves. *Acarothric paulustris* and *Copidognathus balakrishnani* were reported from algal turf growing on *Avicennia* mangrove pneumatophores at Chorao Island, North Goa (Chatterjee, Guru, Sorensen, 2013; Chatterjee, 2015a).

Discussion

Published research work on meiofauna associated with Indian mangroves is summarized in this review. Accordingly, the focus of Indian meiofaunal studies has been on the ecological aspects and qualitative analysis of meiofauna is mostly restricted to group level identification. Very few studies were dedicated to the taxonomy, especially the species level identification of a particular meiofaunal groups such as halacarid mites (Chatterjee et al., 2012; Chatterjee et al., 2013; Chatterjee, 2015a, 2019), nematodes (Sinha et al., 1985, 1987, 1989; Chinnadurai, Fernando, 2006a, c, 2007b; Bhaduri et al., 2015; Parsath et al., 2017; Ansari, Bhadury, 2017), harpacticoid copepods (Kondalarao, 1984; Ingole, Ansari, Parulekar, 1990) and foraminifera (Rajeshwararao et al., 2012) but among them also some studies only listed name of the species without any taxonomic detail.

Most of the reports are based on a single attempt from a particular area which is dedicated to a one particular meiofaunal group mainly. Nonetheless majority of these studies also indicate the meiofauna in Indian mangrove is rich and diverse therefore it is pertinent to suggest that more dedicated attempts are required to get knowledge on the species level information and their functioning in a specific mangrove environment.

Nagelkerken et al. (2008) commented that nematodes were identified as the dominant taxon in most meiofaunal studies conducted in mangrove sediments, followed by harpacticoid copepods. In Indian research, meiofauna associated with mangrove also show similar trends, nematodes as dominant taxa in most of the studies (e.g., Ingole et al., 1987; Sahoo et al., 2013; Annapurna et al., 2015).

Meiofauna from Saphala salt marsh (mangrove area) showed that the meiofaunal density is comparable to that in the mudflats and higher than either seagrass bed or from intertidal sand (Ingole et al., 1987). It was also indicated that the mud flat of salt marsh (mangrove associated area) may favour high meiofaunal population because of the availability of detritus which provide favourable niche for the development of meiofaunal population and become chief factor for the abundance of meiofauna in salt marsh (Ingole et al., 1987). Ansari et al. (1993) also reported that densities of meiofauna were highest near the surface and the abundances were related to the food availability such as chlorophyll-a concentration, diatom number and bacterial counts. Positive correlations between meiofaunal density and diatom abundance are observed in the study of Ansari et al. (1993) and concluded that microbial flora are important in governing the distribution of many meiobenthic forms within the system.

Halacarid mite (Halacaridae, Acari) is one important component in meiofauna group. Halacarid mites were also reported associated with mangroves in different parts of world (Chatterjee, 2015b, Chatterjee et al., 2019). In India, halacarids associated with mangroves were studied only from Goa (Chatterjee et al., 2012, 2013; Chatterjee 2015a, 2019) and therefore the species inventory of this ecosystem is far from being complete. It is therefore recommended to have a special research focus should be set on this remarkable ecosystem in the near future (Chatterjee, Pfingstl, Pesic, 2019).

Kinorhynchs is reported in mangrove meiofauna as rare meiofaunal taxa, representing <1% of the total abundance (Hodda, Nicholas, 1986; Schrijvers et al., 1995; Della Patrona et al., 2016), and the phylum rarely appears with relatively high abundance (Sarma, Wilsanand, 1994; Annapurna et al., 2015; Gomes, Santos, Alves, Rosa-Filho, Souza-Santos, 2002; Santos et al., 2009). Most of the cases kinorhynchs found in these studies were not identified beyond the group level. Only nine species (determined upto specific level) of kinorhynchs reported from mangrove area (Zeppilli et al., 2018). In India, Higgins (1969) reported *Sphenoderes indicus* Higgins 1969 from West Jamnagar, Gujarat (Gulf of Kutch, Arabian Sea), west coast India, at 6 m water depth, in grey-brown mangrove mud. Annapurna et al. (2015) mentioned *Echinoderes bengalensis* in their collection of Kakinada Bay (east coast of India). Sarma and Wilsanand (1994) reported that kinorhynchs were restricted to the station in Bitrakanika mangrove located in river Mahanadi with proximity to the sea.

Our review work suggests that even though a significant number of papers are published on meiofauna from the Indian mangrove habitat, the majority of the studies have focused only on the phylum of taxon or group level identification. Moreover, only a few of the studies have highlighted the role of food availability and abundance of meiofauna within the mangrove mudflat. In addition to the importance of meiofauna in the benthic food chain, larval feeding, meiofauna is also used very effectively in coastal, estuarine and offshore environmental monitoring (Ingole, Goltekar, Gonsalves, Ansari, 2005; Ingole et al., 2006; Nanajkar, Ingole, 2010a, b). We, therefore, feel and strongly recommend that the role of meiofauna, especially the dominant taxa, in the mangrove ecosystem functioning and environmental assessment need to be explored more explicitly.

References

Abdullah, M.M., Lee, S.Y. (2017). Structure of mangrove meiofaunal assemblages associated with local sediment conditions in subtropical eastern Australia. *Estuarine, Coastal and Shelf Science*, *198*, 438–449.

Alongi, D.M. (1987a). Inter-estuary variation and intertidal zonation of freeliving nematode communities in tropical mangrove systems. *Marine Ecology Progress Series*, *40*, 103–114.

Alongi, D.M. (1987b). Intertidal zonation and seasonality of meiobenthos in tropical mangrove estuaries. *Marine Biology*, *95*, 447–458.

Alongi, D.M. (1987c). The influence of mangrove-derived tannins on intertidal meiobenthos in tropical estuaries. *Oceanologia*, *71*, 537–540.

Alongi, D.M. (1988). Microbial-meiofaunal interrelationships in some tropical intertidal sediments. *Journal of Marine Research*, *46*, 349–365.

Alongi, D.M. (1990). Community dynamics of free-living nematodes in some tropical mangrove and sand-flat habitats. *Bulletin of Marine Sciences*, *46*, 358–373.

Alongi, D.M., Christoffersen, P. (1992). Benthic infauna and organism-sediment relations in a shallow, tropical coastal area: Influence of outwelled mangrove detritus and physical disturbance. *Marine Ecology Progress Series*, *81*, 229–245.

Annapurna, C., Rao, M.S., Vijaya Bhanu, C. (2015). Distribution of meiobenthos off Kakinada Bay, Gaderu and Coringa estuarine complex. *Journal of the Marine Biological Association of India*, 57, 17–26.

Ansari, K.G.M.T., Manokaran, S., Raja, S., Lyla, P.S., Khan, S.A. (2014). Interaction of free-living marine nematodes in the artificial mangrove environment (southeast coast of India). *Environmental Monitoring and Assessment*, *186*, 293–305.

Ansari, K.G.M.T., Bhadury, P. (2017). An updated species checklist for free living nematodes from the world's largest mangrove ecosystem, Sundarbans. *Zootaxa*, *4290* (1), 177–191.

Ansari, Z.A., Sreepada, P.A., Matondka, S.G.P., Parulekar, A.H. (1993). Meiofaunal stratification in relation to microbial food in a tropical mangrove mudflat. *Tropical Ecology*, *34* (2), 63–75.

Armenteros, M., Martin, I., Williams, J.P., Creagh, B., Gonzalez-Sanson, G., Capetillo, N. (2006). Spatial and Temporal Variations of Meiofaunal Communities from the Western Sector of the Gulf of Batabano´, Cuba. I. Mangrove Systems. *Estuaries and Coasts*, *29* (1), 124–132.

Arul, B., Sridhar, S.G.D., Hussain, S.M., Darwin Felix, A., Periakali, P. (2003). Distribution of recent benthic Ostracoda from the sediments of Pitchavaram mangroves, Tamil Nadu, Southeast coast of India, *Bulletin of Pure & Applied Science*, *22*, 55–73.

Bhaduri, P., Mondal, N., Ansari, K.G.M.T., Pitale, R., Prasade, A., Nagale, P., Apte, D. (2015). Checklist of free living marine nematodes from intertidal sites along the central west coast of India. *Checklist*, *11* (2), 1–7. DOI: 10.15560/11.2.1605.

Chatterjee, T. (2015a). Scanning electron microscopic observations of *Copidognathus balakrishnani* Chatterjee (Acari: Halacaridae) with notes on species of the *Copidognathus balakrishnani* group. *Acta Biologica*, *22*, 213–222.

Chatterjee, T. (2015b). A checklist of halacarid and pontarachnid mites (Acari: Halacaridae and Pontarachnidae) associated with mangroves. *Ecologica Montenegrina*, *4*, 334–341.

Chatterjee, T. (2019). Scanning electron microscopic observation of *Acarothrix grandocularis* (Acari, Halacaridae) and notes on the species of the genus *Acarothrix*, *Acta Biologica*, *26*, 117–126.

Chatterjee, T., Marshall, D.J., Guru, B.C., Ingole, B., Pesic, V. (2012). A new species of the genus *Acarothrix* (Acari: Halacaridae) from Brunei Darussalam and India, *Cahiers de Biologie Marine*, *53*, 541–546.

Chatterjee, T., Guru, B.C., Sorensen, M.V. (2013). Report of *Acarothrix palustris* Bartsch (Acari: Halacaridae) from the Indian Ocean. *Acta Biologica*, *20*, 17–26.

Chatterjee, T., Pfingstl, T., Pesic, V. (2019). A checklist of marine littoral mites (Acari) associated with mangroves, *Zootaxa*, *4442* (2), 221–240. DOI: 10.11646/zootaxa.4442.2.2.

Chinnadurai, G., Fernando, O.J. (2003). Meiofauna of Pichavaram mangroves along the outheast coast of India. *Journal of the Marine Biological Association of India*, *45*, 158–165.

Chinnadurai, G., Fernando, O.J. (2006a). New records of free living marine nematodes from India. *Records of Zoological Survey of India*, *106* (4), 45–54.

Chinnadurai, G., Fernando, O.J. (2006b). Meiobenthos of Cochin mangrove (Southwest coast of India) with emphasis on free-living marine nematode assemblages. *Russian Journal of Nematology*, *14* (2), 127–137.

Chinnadurai, G., Fernando, O.J. (2006c). New records of five free living marine nematodes from an artificial mangroves of India. *Journal of the Marine Biological Association of India*, *48* (1), 105–107.

Chinnadurai, G., Fernando, O.J. (2007a). Impact of Mangrove Leaves on Meiofaunal Density: An Experimental Approach. *The IUP Journal of Life Sciences*, *1* (1), 62–70.

Chinnadurai, G., Fernando, O.J. (2007b). Meiofauna of mangroves of the southeast coast of India with special reference to the free-living marine nematode assemblage. *Estuarine, Coastal and Shelf Science*, *72*, 329–336.

Coull, B.C., Greenwood, J.G., Fielder, D.R., Coull, B.A. (1995). Subtropical Australian juvenile fish eat meiofauna: experiments with winter whiting Sillago maculata and observations on other species. *Marine Ecology Progress Series*, *125*, 13–19.

Das, A.K., Dev Roy, M.K. (1989). A general account of the Mangrove fauna of Andaman & Nicobar Islands. *Conservation Area Series*, *4*, 1–178.

Della Patrona, L., Marchand, C., Hubas, C., Molnar, N., Deborde, J., Meziane, T. (2016). Meiofauna distribution in a mangrove forest exposed to shrimp farm effluents (New Caledonia). *Marine Environmental Research*, *119*, 100–113.

Dittel, A.I., Epifanio C.E., Cifuentes L.A., Kirchman, D.L., (1997). Carbon and nitrogen sources for shrimp postlarvae fed natural diets from a tropical mangrove system. *Estuarine Coastal and Shelf Science*, *45*, 629–637.

Dye, A.A. (1983a). Composition and seasonal fluctuation of meiofauna in a southern African mangrove estuary. *Marine Biology*, *73*, 165–170.

Dye, A.A. (1983b). Oxygen consumption by sediments in a southern African mangrove swamp. *Estuarine Coastal and Shelf Science*, *17*, 473–478.

Fell, J.W., Cefalu, R.C., Masters, I.M., Tallman, A.S. (1975). Microbial activity in the mangrove *(Rhizophora mangle)* leaf detritus system. In: G.E. Walsh et al. (eds.), *Proceedings of the International Symposium on the Biology and Management of Mangroves, Honolulu, 1974, vol. II* (pp. 661–679). Gainsville: University of Florida.

FSI (2013). India State of Forest Report 2013, Forest Survey of India, Dehradun, India.

Ganapati, P.N., Sarma, A.L.N. (1973). The meiofauna and pollution in Visakhapatnam harbour. *Current Science*, *42* (20), 724–725.

Gee, J.M., Somerfield P.J. (1997). Do mangrove diversity and leaf litter decay promote meiofaunal diversity? *Journal of Experimental Marine Biology and Ecology*, *218*, 13–33.

Goldin, Q., Mishra, V., Ullal, V., Athalye, R.P., Gokhale, K.S. (1996). Meiobenthos of mangrove mudflats from shallow region of Thanecreek, central west coast of India. *Indian Journal of Marine Sciences*, *25*, 137–141.

Gomes, C.A.A., Santos, P.J.P., Alves, T.N.C., Rosa-Filho, J.S., Souza-Santos, L.P. (2002). Variação temporal da meiofauna em área de manguezal em Itamaracá-Pernambuco [Temporal variation of meiofauna in mangrove area in Itamaracá-Pernambuco]. *Atlântica*, *24* (2), 89–96.

Gwyther, J., Fairweather, P.G. (2005). Meiofaunal recruitment to mimic pneumatophores in a cool-temperate mangrove forest: spatial context and biofilm effects. *Journal of Experimental Marine Biology and Ecology*, *317*, 69–85.

Higgins, R.P. (1969). Indian Ocean Kinorhyncha: 1, *Condyloderes* and S*phenoderes*, new cyclorhagid genera. *Smithsonian Contributions to Zoology*, *14*, 1–13.

Hodda, M., Nocholas, W.L. (1985). Meiofauna associated with mangroves in the Hunter river estuary and Fullerton Cove, South eastern Australia. *Australian Journal of Marine and Freshwater Research*, *36* (1), 41–50.

Hodda, M., Nicholas, W.L. (1986). Temporal changes in littoral meiofauna from the Hunter River estuary. *Australian Journal of Marine and Freshwater Research*, *37*, 729–741.

Hopper, B.E., Fell, J.W., Cefalu, R.C. (1973). Effect of temperature on life cycles of nematodes associated with the mangrove (Rhizophora mangle) detritus system. *Marine Biology*, *23*, 293–296.

Ingole, B.S., Ansari, Z.A., Parulekar, A.H. (1987). Meiobenthos of Saphala salt marsh, west coast of India. *Indian Journal of Marine Science*, *16*, 110–113.

Ingole, B.S., Ansari, Z.A., Parulekar, A.H. (1990). Benthic Harpacticoid copepod community of Saphala salt marsh along the West coast of India. *Indian Journal of Marine Science*, *19*, 217–220.

Ingole, B.S., Goltekar, R. Gonsalves, S., Ansari, Z.A. (2005). Recovery of Deep-sea Meiofauna after Artificial Disturbance in the Central Indian Basin. *Marine Georesources & Geotechnology*, *23*, 253–266.

Ingole, B., Sivadas, S., Goltekar, R., Clemente, S., Nanajkar, M., Sawant, R., D'Silva, C., Sarkar, A., Ansari, Z. (2006). Ecotoxicological effect of grounded *MV River Princess* on the intertidal benthic organisms off Goa. *Environment International*, *32* (2), 284–291.

Kondalarao, B. (1983). Distribution of meiofauna in Gautami Godavari estuarine system. *Mahasagar-Bulletin of the National Institute of the Oceanography*, *16* (4), 453–457.

Kondalarao, B. (1984). Distribution of meiobenthic harpacticoids copepods in Gautami Godavari estuarine system. *Indian Journal of Marine Science*, *13*, 80–84.

Krishnamurthy, K., Sultan Ali, M.A., Jeyaseelan, M.J.P. (1984). Structure and dynamics of the aquatic food web community with special reference to nematodes in mangrove ecosystem. In: E. Soepadmo, A.N. Rao, D.J. MacIntosh (eds.), *Proceedings of the Asian Symposium on Mangrove Environment: Research and Management* (pp. 429–452), 1984. Kuala Lumpur: University of Malaya.

Kumar, V., Hussain, S.M. (1997). A Report on Recent Ostracoda from Pitchavaram Mangroves, Tamilnadu. *Geosciences Journal*, *18*, 131–139.

Kurapati, R.K., Dogiparti, A., Daddu, S.K. (2016). Spatio-Temporal Variation of Meio-fauna Distribution in Bhavanapadu Creek, Srikakulam District, Andhra Pradesh, India. *British Journal of Applied Science & Technology*, *12* (1), 1–10.

Mandal, A.K., Nandi, N.C. (1989). Fauna of Sundarban Mangrove Ecosystm, west bengal, India. *Fauna of Conservation Areas*, *3*, 1–136.

Mandal, R.N., Naskar, K.R. (2008). Diversity and classification of Indian mangroves: a review. *Tropical Ecology*, *49*, 131–146.

Mohan, P.M., Dhivya, P., Sachithanandam, V., Ragavan, P. (2012). Distribution of mangrove meiofaunal composition inrelation to organic carbon and carbonate in Port Blair, South Andaman, India, In: *Tropical Ecosystems Structure, Function and Services* (pp. 47–54). Published by Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore.

Murty, K.V.R., Kondalarao, B. (1987). Survey of meiofauna in the Gautami Godavari estuary. *Journal of the Marine Biological Association, India*, *29* (1&2), 37–44.

Mutua, A.K., Muthumbi, A., Ntiba, M.J., Vanreusel, A. (2013). Patterns of meiofaunal colonisation as an indicatorof reforested *Rhizophora mucronata* mangrove recovery in Gazi Bay, Kenya. *Western Indian Ocean Journal of Marine Science*, *12* (1), 23–25.

Nagelkerken, I., Blader, S.J.M., Bouillon, S., Green, P., Haywood, M., Kirton, L.G., Meynecke, J.O., Pawlik, J., Penrose, H.M., Sasekumar, A., Somerfield, P.J. (2008). The habitat function of mangroves for terrestrial and marinefauna: A review. *Aquatic Botany*, *89*, 155–185.

Nanajkar, M., Ingole, B.S. (2010a). Impact of sewage disposal on a nematode community of a tropical sandy beach. *Journal of Environmental Biology*, *31*, 819–826.

Nanajkar, M., Ingole, B.S. (2010b). Comparison of tropical nematode community from three harbours, west coast of India. *Cahiers de Biologie Marine*, *51*, 9–18.

Naskar, K.R., Mandal, R.N. (1999). *Ecology and Biodiversity of Indian Mangroves*. New Delhi, India: Daya Publishing House.

Ólafsson, E.E. (1995). Meiobenthos in mangrove areas in eastern Africa with emphasis on assemblage structure of free-living marine nematodes. *Hydrobiologia*, *312*, 47–57.

Ólafsson, E.E., Carlström, S., Ndaro, S.G. (2000). Meiobenthos of hypersaline tropical mangrove sediment in relation to spring tide inundation. *Hydrobiologia*, *426*, 57–64.

Parulekar, A. (1994). Benthic fauna of mangrove environment. In: V.D. Sanjay, V. Balaji (eds.), *Conservation of Mangrove Forest Genetic Resources: A training manual* (pp 253–255). CRSARD, Chennai.

Parsath, D., Balasubramaniam, J., Marimuthu, P., Jayaraj, K.A. (2017). New record of two free-living marine nematode species, *Sphaerolamius balticus* and *Sphaerolamius islandicus* (Nematoda: Sphaerolaimaidae) from Sippighat mangrove region, South Andaman. *Indian Journal of Geo-Marine Sciences*, *46* (5), 1105–1109.

Parsath, D., Balasubramaniam, J., Jayraj, K.A. (2018). Diversity and distribution of the free-living marine nematodes in the mangrove sediments of the Andaman Isklands. *Indian Journal of Geo Marine Sciences*, *47* (11), 2217–2224.

Pinto, T.K., Austen, M.C.V., Warwick, R.M., Somerfield, P.J., Esteves, A.M., Castro, F.J.V., Fonseca-Genevois, V.G., Santos, P.J.P. (2013). Nematode diversity in different microhabitats in a mangrove region. *Marine Ecology*, *34*, 257–268.

Rajeshwararao, N., Geetha, C., Shanmhugavel, S. (2012). Benthic foraminiferal colonization of a new mangrove ecosystem – a case study from Pazhaiyakayal, Tuticorin, south-east coast of India. *Journal of Palaeontological Society of India*, *57*, 119–127.

Rao, G.C. (1986). Meiofauna of the mangrove sediments in South Andaman. *Journal of Andaman Science Association*, *2*, 23–32.

Sahoo, G., Suchiang, S., Ansari, Z.A. (2013). Meiofauna-Mangrove interaction: a pilot study from a tropical mangrove habitat. *Cahiers de Biologie Marine*, *54* (3), 349–358.

Sahu, S.C., Suresh, H.S., Murthy, I.K., Ravindranath, N.H. (2015). Mangrove Area Assessment in India: Implications of Loss of Mangroves. *Journal of earth science and climate change*, *6* (5), online published. DOI: 10.4172/2157-7617.1000280.

Santos, P.J.P., Botter-Carvalho, M., do Nascimento-Júnior, A.B., Marinho, R.G.C., Carvalho P.V.V.C., Valebça, A.P.M.C. (2009). Response of estuarine meiofauna assemblage to effects of fertilizer enrichment used in the sugar cane monoculture. Pernambuco, Brazil. *Brazil Journal of Oceanography*, *57*, 43–55.

Sarma, A.L.N., Wilsanand, V. (1994). Littoral meiofauna of Bhitarkanika mangroves of river Mahanadi system, East coast of India. *Indian Journal of Marine Science*, *23*, 221–224.

Sasekumar, A. (1994). Meiofauna of a mangrove shore on the west coast of peninsular Malaysia. *Raffles Bulletin of Zoology*, *42*, 901–915.

Schrijvers, J., Okondo, J., Steyaert, M., Vincx, M. (1995). Influence of epibenthos on meiobenthos of the Ceriops tagal mangrove sediment at Gazi Bay, Kenya. *Marine Ecology Progress Series*, *128*, 247–259.

Sinha, B., Choudhury, A., Baqri, Q.H. (1985). Studies on the nematodes from mangrove swamps of deltaic Sundarbans, West Bengal. *I. lndoditylenchus sundarbanensis* n. gen., n. sp. (Tylenchidae: Tylenchida). *lndian J. Helmenthology (n.s)*, *2*, 31–35.

Sinha, B., Choudhury, A., Baqri, Q.H. (1987). Studies on the nematodes from mangrove swanlps of deltaic Sundarbans, West Bengal, India. III. *Anoplostoma niacrospiclilull* n. sp. (Anoplostomatidae: Nematoda). *Current Science*, *56* (11), 539–540.

Sinha, B., Baqri, Q.H., Choudhury, A. (1989). On the males of *Indoditylenchus sundarbanensis* sinha, Choudhury and Baqri, 1985 and *Nothocriconema bengalensis* Sp. N. (Tylenchida: Nematoda) from Sundarbans, west Bengal. *Indian Journal of Nematology*, *19* (2), 100–104.

Somerfield, P.J., Gee, J.M., Aryuthaka, C. (1998). Meiofaunal communities in a Malaysian mangrove forest. *Journal of Marine Biological Association of United Kingdom*, *78*, 717–732.

Savurirajan, M, Jayabarathi, R., Padmavati, G., Ganesh, T. (2012). Species composition, abundance and diversity of meiobenthic fauna in mangrove sediments of south Andaman islands In: D.R. Singh, M. Sankaran, S. Singh, K. Abirami, S. Dam Roy (eds.), *Souvenir,, National Seminar on Innovative Technologies for Conservation and Sustainable Utilization of Island Biodiversity* (pp. 222–233). Port Blair: Central Agricultural Research Institute.

Sunil Kumar, R. (2000). A review of biodiversity studies of soil dwelling organisms in Indian mangroves. *Zoos' Print Journal*, *15* (3), 221–227.

Sunil Kumar, R. (2001). A checklist of polychaetaous annelids from some Indian mangroves. *Zoos' Print Journal*, *16* (3), 439–441.

Sundaravarman, K., Kathiresan, K., Saravanakumar, A., Balasubramanian, T. (2012). Studies on a mangrove lagoon at muthupet, southeast coast of India. *International Journal of Current Research*, *4* (9), 15–22.

Sultan Ali, M.A., Krishnamurthy, K., Prince Jeyaseelsn, M.J. (1983). Energy flow through the benthic ecosystem of the mangroves with special reference to nematodes. *Mahasagar*, *Bulletin of the National Institute of Oceanography*, *16* (3), 317–325.

Thilagavathi, B., Das, B., Saravanakumar, A., Raja, K. (2011). Benthic Meiofaunal Composition and Community Structure in the Sethukuda Mangrove Area and Adjacent Open Sea, East Coast of India. *Ocean Science Journal*, *46* (2), 63–72.

Untawale, A.G., Wafar, S., Jagtap, T.G. (1982). Application of remote sensing technique to study the distribution of mangroves along the estuaries of Goa. In: *Proceedings of First International Wetland Conferance* (pp. 51–67).

Untawale, A.G. (1984). *Mangroves of India:* Present status and multiple use and practices. Status report submitted to the UNDP/UNESCO Regional mangrove project for Asia and the Pacific.

Vidya, P., Patil, R.K. (2014). Mangrove sediment core analysis of foraminiferal assemblages – astudy at two sites along the western coast of India. *Journal of Threatened Taxa*, *6* (2), 5485–5491.

Zeppilli, D., Leduc, D., Fontanier, C., Fontanetom, D., Suchs, S., Gooday, A.J., Goineau, A., Ingels, J., Ivanenko, V.N., Kristensen, R.M., Neves, R.C., Sanchez, N., Sandulli, R., Sarrazin, J., Sørensen, M.V., Tasiemski, A., Vanreusel, A., Autret, M., Bourdonnay, L., Claireaux, M., Coquillé, V., Wever, L.D., Rachel, D., Marchant, J., Toomey, L., Fernandes, D. (2018). Characteristics of meiofauna in extreme marine ecosystems: a review. *Marine Biodiversity*, *48*, 35–71. DOI: 10.1007/s12526-017-0815-z.

Zhou, H. (2001). Effects of leaf litter addition on meiofaunal colonization of azoic sediments in a subtropical mangrove in Hong Kong. *Journal of Experimental Marine Biology and Ecology*, *256*, 99–121.

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